# CHAPTER 4

# MAIN POWER SYSTEM

## 4-1. Description of main power system

The following is a sample main power system with associated one-line and wiring diagrams for use as a guide for implementing the test procedures described in the preceding chapters of this manual. The major equipment in this main power system includes 34.5 kV circuit switchers, 15,000 kVA oil filled transformers, and 13.8 kV metal clad switchgear including relays and controls. The equipment, accessories, interconnections, ratings, and cabling are shown in figures 4-1 through 4-7. Figure 4-1 diagrams the main power system single line on page 4-7. Figure 4-2 diagrams the main power system control cable block on page 4-8. Figure 4-3 diagrams the main power system circuit switcher on page 4-9. Figure 4-4 diagrams the main power system switchgear load breaker on page 4-10. Figure 4-5 diagrams the main power system switchgear incoming breaker on page 4-11. Figure 4-6 diagrams the main power system circuit switcher wiring diagram on page 4-12. Figure 4-7 diagrams the main power system incoming breaker wiring on page 4-13.

*a. Switches.* The 34.5 kV Circuit Switchers are outdoor vertical break, shunt trip with full momentary current capability and limited fault current interrupting for applications feeding power transformers. Each switch contains a high speed high torque power operator, interrupting units, disconnects, and post insulators. The operator receives a trip or open signal from relays or a control switch, trips the interrupter, and then opens the disconnect. If too much shunt current is available the relaying scheme will block the switch from opening until the current decreases to an acceptable level. Each circuit switcher has a 125 Vdc control circuit for control, relaying, and operator power. The circuit switcher is intended to operate on transformer overload, transformer secondary faults, transformer through faults not cleared by down stream switchgear breakers, and low value high resistance transformer faults. The 12/15 MVA power transformers are outdoor oil filled with radiators and fans for cooling, temperature and fault indicating relays, bushing mounted current transformers, no load secondary tap changer, and a control and alarm panel. The control and alarm panel requires a 120/208V, three phase power source for the controls, cabinet heater, and alarms. The 13.8 kV switchgear is indoor, metal clad with individual spring operated vacuum circuit breakers and controls.

*b. Breakers.* The switchgear line-up contains two incoming, one tie, and eight load breakers. Each breaker has a relay/control compartment containing a control switch, indicating lights, relays, control wiring, and terminal blocks. The breakers have electrical and mechanical interlocks to prevent inadvertent operation, open/close springs, spring charging motors, position switches, and close and test positions. An auxiliary compartment in the switchgear is used to house the circuit switchers' control, indication, relays, and remote alarms; and the transformer remote alarms. For control, each circuit switcher and switchgear breaker has a control switch, indicating lights and relays. Each circuit switcher trip circuit contains overcurrent, differential current, transformer overload lockout, and transformer sudden pressure relays. The switchgear and load breakers have overcurrent relays. The tie breaker has no relaying, and is intended to be closed to the switchgear bus together when a transformer is out of service. It is interlocked to open or block closure if both of the incoming breakers are closed. There are potential transformers (PTs) on both sides of the switchgear and load circuit breakers. They are connected to undervoltage relays and sync check relays. The switchgear requires a 125 Vdc control and relay feed and 120 V single phase feed for space heaters.

## 4-2. Operation of main power system

The operating modes for the main power system are as follows. These are some of the steps that would be included in a systems operation document (SOD).

*a. Normal condition.* Both circuit switchers closed, both transformers energized, both switchgear breakers closed, tie breaker open, and load breakers closed.

*b. Transformer problem.* Associated circuit switcher and switchgear breaker open automatically, other circuit breaker and switchgear breaker remain closed, and tie breaker closes automatically into dead bus.

*c. Transformer maintenance.* Transformer to be maintained selected, tie breaker closed into live bus and incoming breaker opened for transformer to be maintained, and circuit switcher for transformer to be maintained opened

*d. Return to normal.* Circuit switcher for deenergized transformer closed and switchgear breaker closed to live bus and tie breaker opened.

NOTE: Automatic closing of the tie breaker during protective relay functions is a dead bus transfer. Manually closing of tie breaker or closing of incoming breaker with tie breaker closed will parallel both transformers and sync check relays will not permit breaker closing if the busses are not synchronized.

## 4-3. Commissioning test plan for main power system

A system verification and functional performance test should be performed on the main power system. These tests will include installation inspections, individual component testing, verification and continuity testing on wiring, control and interlock function checks, equipment energization, system operating measurements, and functional tests.

## 4-4. Installation inspections and component testing of main power system

As indicated in more detail in chapter 3, the installation of the main components (i.e. circuit switchers, transformers, and 13.8 kV switchgear) will be inspected for the following. These checks can be considered part of the pre-checks or the functional performance tests (FPTs).

*a. Circuit switcher.* Verification of nameplate, sizing, and settings against drawings, completeness of assembly, loose parts and insulation damage, alignment and operation including limit switches and interlocks, insulation resistance test on each pole, interrupter time travel analysis and proper grounding. Figure 4-8 on page 4-14 shows a sample of a completed DA Form 7463-R for a circuit switcher.

*b. Oil-filled transformer.* Verification of nameplate, size and settings against drawings, completeness of assembly, loose parts and insulator damage, seals and oil levels, auxiliary device operation and settings for radiators, fans, cooling, alarms, gauges, tap changer, etc., proper grounding, insulating liquid dielectric, acid neutralization, specific gravity, quality, color, etc., insulation resistance phase-to-phase, phase-to-ground, current transformers, turns ratio – high-to-low windings at all taps, current transformers at all taps and impedance and polarity on current transformers. Figure 4-9 shows a sample of a completed DA Form 7464-R for a transformer.

*c. Metal clad switchgear.* Verification of nameplate, sizing, and settings against drawings, completeness of assembly, loose parts and insulation damage, breaker alignment and operation (leave open) including limit switches and interlocks, bus insulation resistance (if not previously energized), relay calibration and settings including current transformer primary injection, insulator damage, proper grounding and current/potential

transformer insulation resistance, turns ratio, and polarity. Figure 4-10 on page 4-16 shows a sample of a completed DA Form 7565-R for the switchgear.

*d. Cabling.* Proper use, voltage, labeling, and connections using drawings, tightness and neatness of terminations, and power cable insulation resistance (phase-to-phase and phase-to-ground). Figure 4-11 on page 4-17 shows a sample of a completed DA Form 7466-R for power cables.

*e. Visual and electrical wiring inspections.* The termination of each cable, shown on the cable block and wiring diagrams, should be checked to ensure each conductor matches the wiring and schematic diagrams. This is performed by yellowing each connection from the schematic to the wiring diagram; visually inspecting each connection for cable number, wire number/color, and terminal; and checking point-to-point continuity or "ringing out" each wire from end-to-end including grounds. For example, Cable CIS from Circuit Switcher I to the Switchgear Control Panel should be checked to verify schematic diagrams (figure 4-6).

| **Equipment** | **Terminal No.** |
|---|---|
| Circuit Switcher | 2 |
| Switchgear Control Panel | 1 |

As this is done, the wire on each drawing should be colored or highlighted to show its termination has been checked. This process should be completed for all field wiring as a minimum and internal wiring if not previously performed at the factory.

## 4-5. Energizing and test of the main power system

The following are the steps to energize and test the main power system. These are some of the steps that would be included in a functional performance test (FPT).

*a. Initial energization.* The control circuits for each component shall be sequentially energized from the circuit switcher down to the switchgear load breakers with the utility fuses removed. The control and interlock functions for each circuit shall be verified by opening or closing the control switches, protective and lockout relay contacts, temperature switches, etc. with both circuit switchers closed, all switchgear circuit breakers closed, and the switchgear tie breakers open. For example, on a circuit switcher the functions as shown on table 4-1 should be performed and checked. Verify operation of transformer circuits as in (1) and (2) below.

*Table 4-1. Circuit switcher functional checklist*

| **Function** | **Action to Check** |
|---|---|
| 1) Energize Close/Trip Circuit | Green Light On<br>Red Light Off<br>Switcher Open<br>Verify 86C/86I Normal |
| 2) Close Control Switch | Red Light On<br>Green Light Off<br>Switcher Closed |
| 3) Trip Control Switch | Green Light On<br>Red Light Off<br>Switcher Closed |
| 4) Reclose Circuit Switcher | Red Light On<br>Green Light Off<br>Switcher Closed |

*Table 4-1. Circuit switcher functional checklist (continued)*

| | |
|---|---|
| 5) Trip 86C | Green Light On<br>Red Light Off<br>Switcher Open<br>86C Tripped<br>Switcher Won't Reclose using Control Switch |
| 6) Reset 86C | Green Light On<br>Red Light Off<br>Switcher Open |
| 7) Close Control Switch | Red Light On<br>Green Light Off<br>Switcher Closed |
| 8) Trip 86I | Green Light On<br>Red Light Off<br>Switcher Open<br>86C Tripped<br>Switcher Won't Reclose using Control Switch |
| 9) Reset 86I | Green Light On<br>Red Light Off<br>Switcher Open |
| 10) Close Circuit Switcher | Red Light On<br>Green Light Off<br>Switcher Closed |

*(1) Transformer trip.* Verify circuit switchers and incoming breakers closed and tie breaker open. Simulate transformer trip by operating Transformer 87 relay. Verify 86's trip; and then associated circuit switcher and incoming breaker opens, and tie breaker closes transfer. Verify tie breaker transfer is "dead" bus by measuring continuity from high side of incoming breaker to unaffected bus. Reclose 86, circuit switcher, and incoming breaker. Open tie breaker. Repeat above process for other transformer.

*(2) Transformer maintenance.* Verify circuit switchers and incoming breakers closed and tie breaker open. Choose transformer to be removed from service. Close tie breaker. Open circuit switcher and incoming breaker for transformer to be maintained. Verify tie breaker transfer is "live" bus by measuring. Reclose circuit switcher and incoming breaker. Open tie breaker. Verify tie breaker transfer is "live" bus. Repeat above process for other transformer.

*b. Energization of main power system.* Individual components of the system shall be sequentially energized from the circuit switcher through the switchgear load breaker with the utility fuses installed as follows:

*(1) Circuit Switcher 1 & 2.* Verify main switchgear breaker open. Verify incoming voltage and phasing. Close circuit switcher. Measure voltage on secondary of transformer. Compare voltage and phasing on both transformer secondaries.

*(2) 13.8 kV switchgear.* Verify tie breaker and load breakers open. Close incoming breakers. Measure voltage on switchgear bus. Compare voltage and phasing across tie breaker, close and open tie breaker. Close load breakers one at a time. Measure voltage and current after closing each load breaker.

*(3) Transformer trip test.* Verify system energized with both circuit switchers closed, switchgear incoming and load breakers closed, and tie breaker open. Notify plant of impending transfer. Simulate transformer trip by operating 50/51 relay. Verify 86C trips and then associated circuit switcher and incoming breaker open and tie breaker closes. Measure voltage and current on switchgear buses and verify "dead" bus transfer of tie breaker. Reclose 86C circuit switcher, and incoming breaker. Open tie breaker. Verify tie breaker transfer is "live" bus by measuring bus voltages and current. Repeat above process for other transformer.

*(4) Transformer maintenance test.* Verify system energized with both circuit switchers closed, switchgear incoming and load breakers closed, and tie breaker opened. Notify plant of impending transfer. Choose transformer to be removed from service. Close tie breaker. Open circuit switcher and incoming breaker for transformer to be maintained. Verify tie breaker transfer is "live" bus by measuring voltage and current on switchgear buses. Reclose circuit switcher and incoming breaker. Open tie breaker. Verify tie breaker transfer is "live" bus. Repeat above process for other transformer.

*(5) Checklists.* The acceptance testing is complete when all test are performed satisfactorily and checklists for system components are complete. Figure 4-12 shows a sample of a completed DA Form 7467-R.

## 4-6. Possible failures and corrective actions of the main power system

Table 4-2 lists general problems that may arise during the testing of the equipment and systems along with possible troubleshooting techniques. For all problems, consult the equipment and component manuals for troubleshooting directions, check fuses/lights/breakers/etc. for continuity, check equipment calibration and settings, and look for faulty equipment or connections.

*Table 4-2. Possible failures and corrective actions of the main power system*

| Circuit Switcher | Areas to Check |
|---|---|
| Devices will not close/trip | Mechanical alignment/Limit Switches<br>Interlocks<br>Relay and protective device settings and operation<br>Check for mis-wired circuits<br>Control circuit |
| Devices trip inadvertently | Relay and protective device settings and operation<br>Check for mis-wired circuits<br>Control circuit<br>System overload or short<br>Ground on cable system |

*Table 4-2. Possible failures and corrective actions of the main power system (continued)*

| Breaker | Areas to Check |
|---|---|
| Devices will not close/trip | Mechanical alignment/Limit Switches<br>Interlocks<br>Relay and protective device settings and operation<br>Check for mis-wired circuits<br>Control circuit |
| Devices trip inadvertently | Relay and protective device settings and operation<br>Check for mis-wired circuits<br>Control circuit<br>System overload or short<br>Ground on cable system |

| Transformer | Areas to Check |
|---|---|
| Transformer trips | System overload<br>Cooling system<br>Transformer internal short or bushing failure<br>Transformer relay settings and operation<br>Check for mis-wired circuits<br>Transformer oil |
| Transformer overheats | System overload<br>Cooling system |

| Main Power System | Areas to Check |
|---|---|
| Devices will not close | Mechanical alignment/Limit Switches<br>Interlocks<br>Check for mis-wired circuits<br>Control circuit |
| Inadvertent trips | System overload<br>Cable shorts or grounds<br>Equipment shorts or grounds<br>Transformer cooling<br>Check for mis-wired circuits<br>Relay and protective device settings |

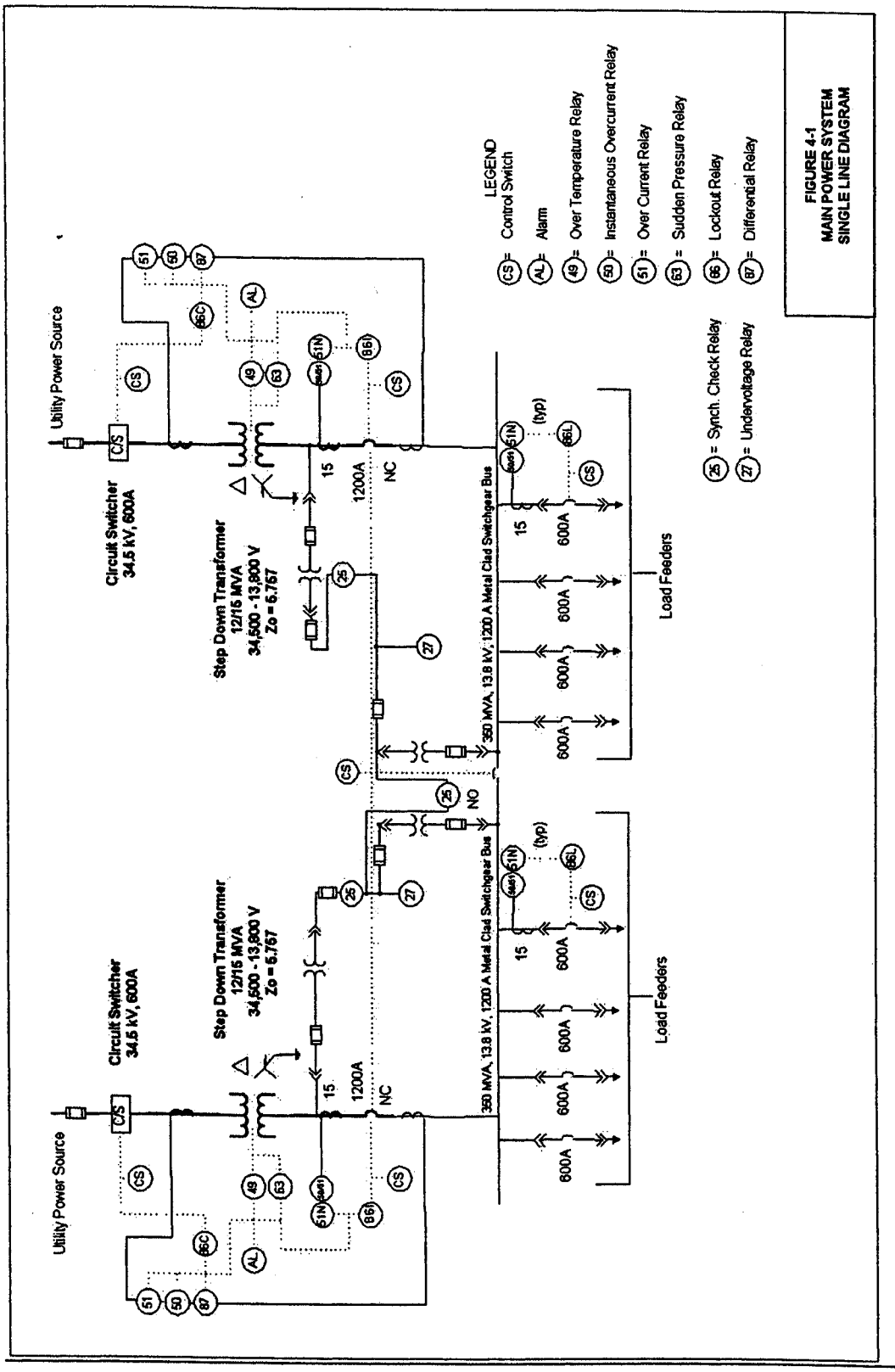


*Figure 4-1. Main power system single line diagram*

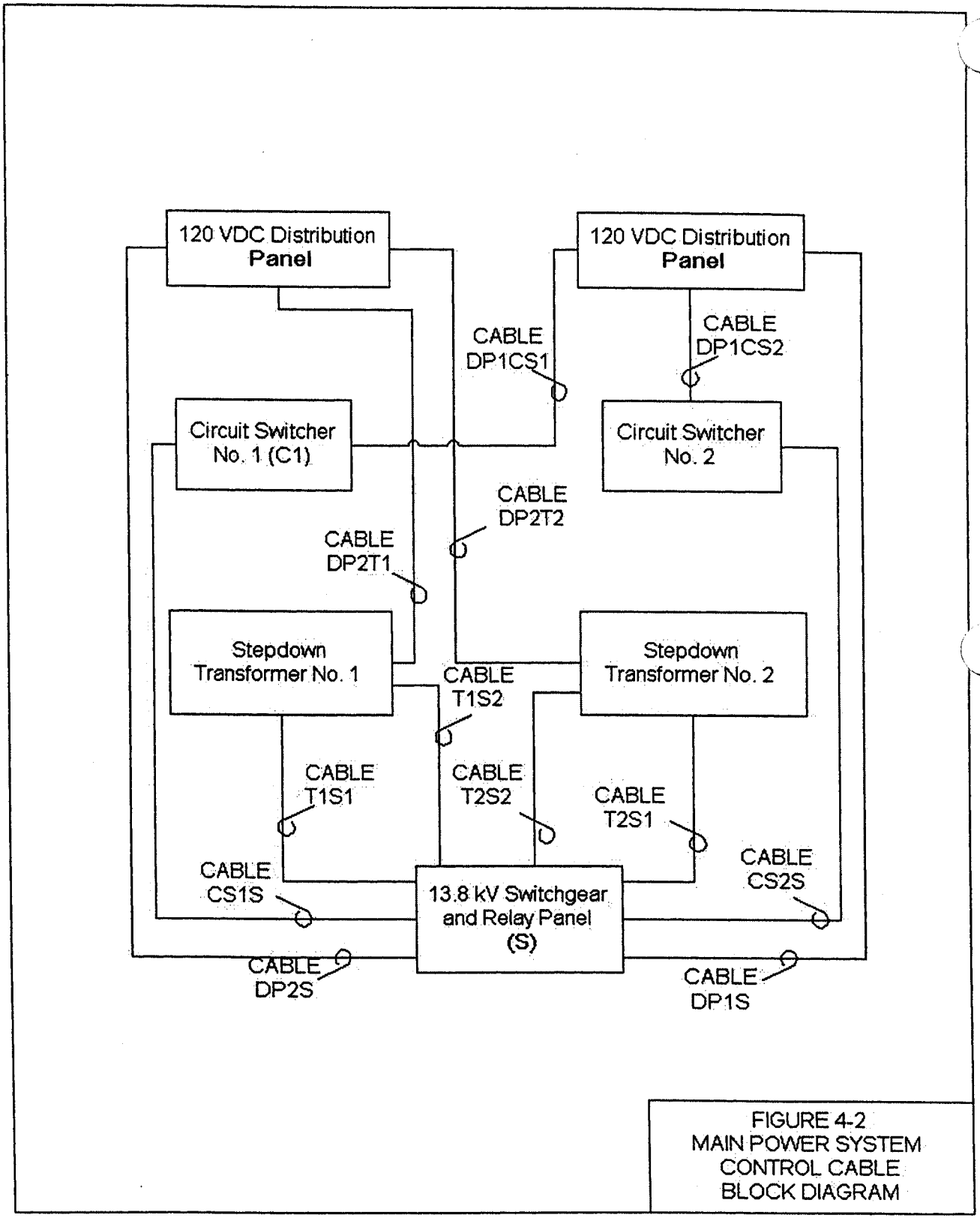


*Figure 4-2. Main power system control cable block diagram*

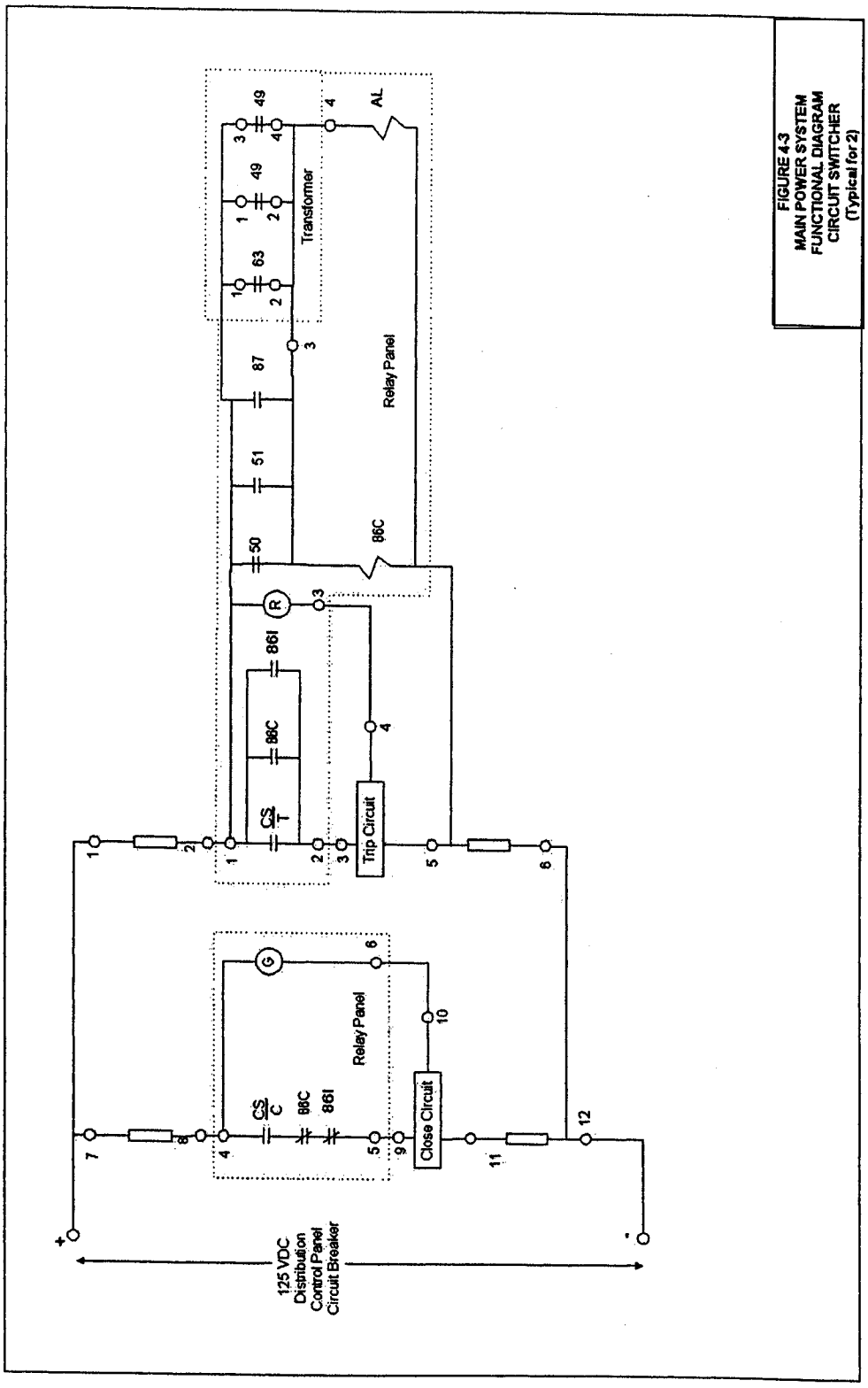


*Figure 4-3. Main power system functional diagram circuit switcher (typical for 2)*

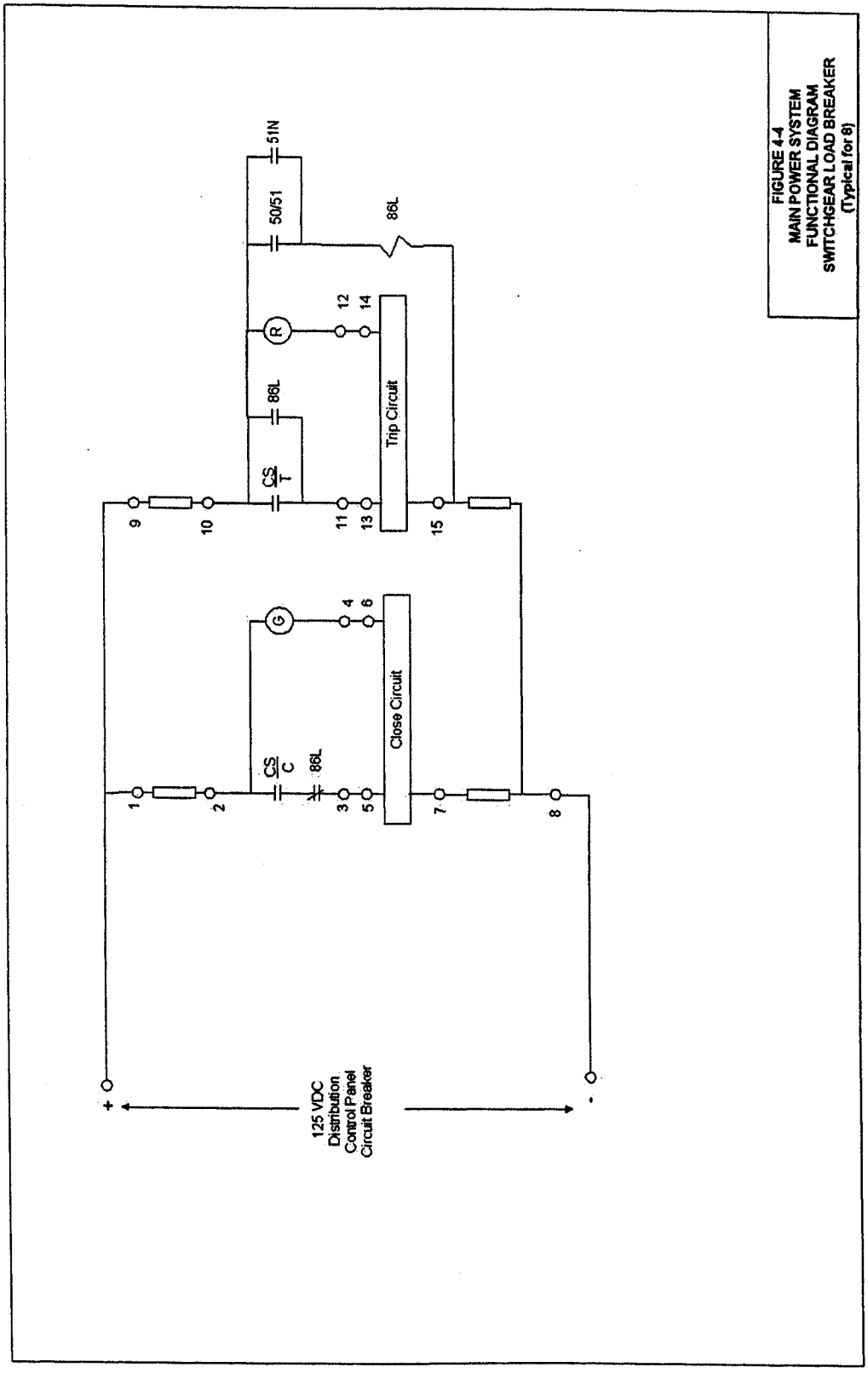


*Figure 4-4. Main power system functional diagram switchgear load breaker (typical for 8)*

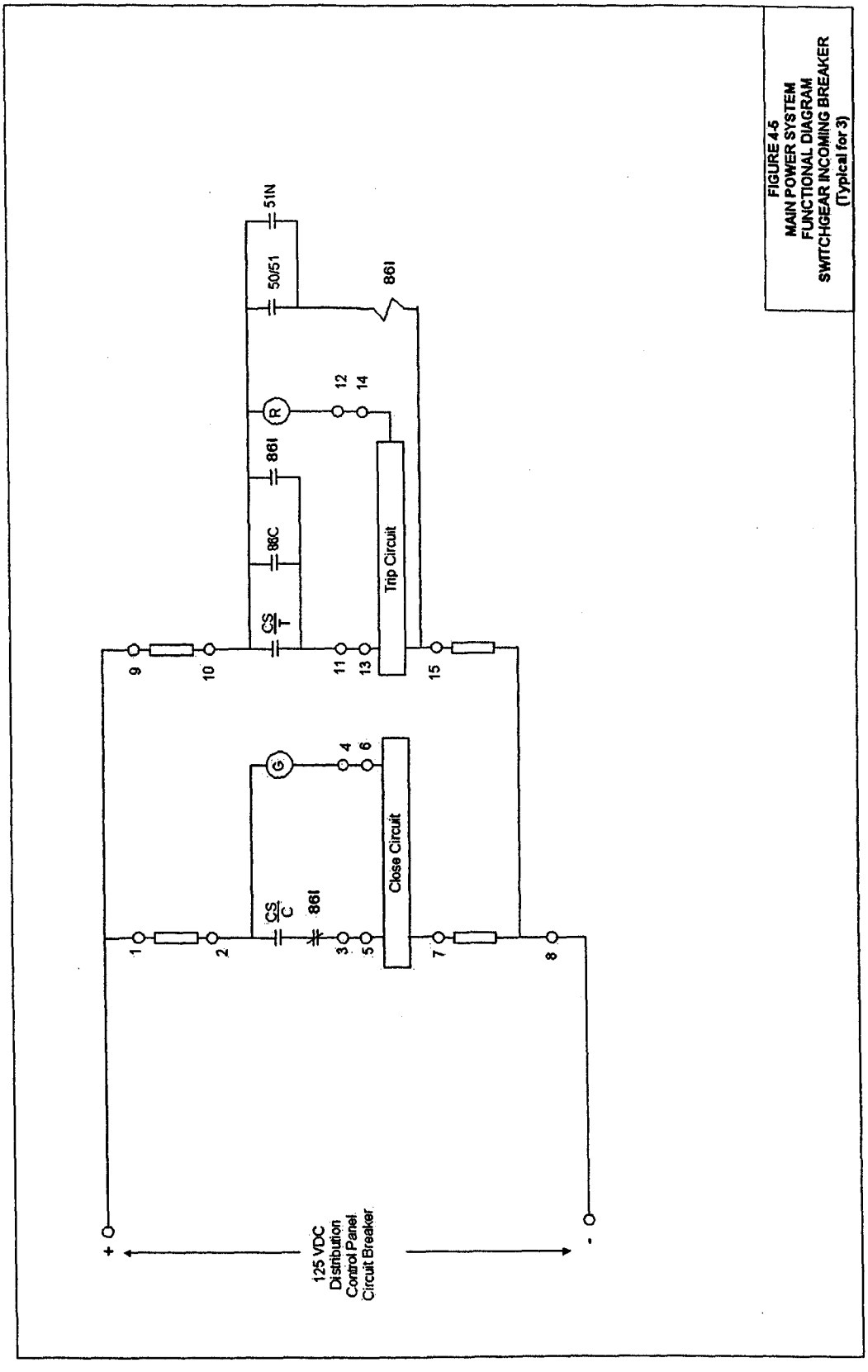


*Figure 4-5. Main power system functional diagram switchgear incoming breaker (typical for 3)*

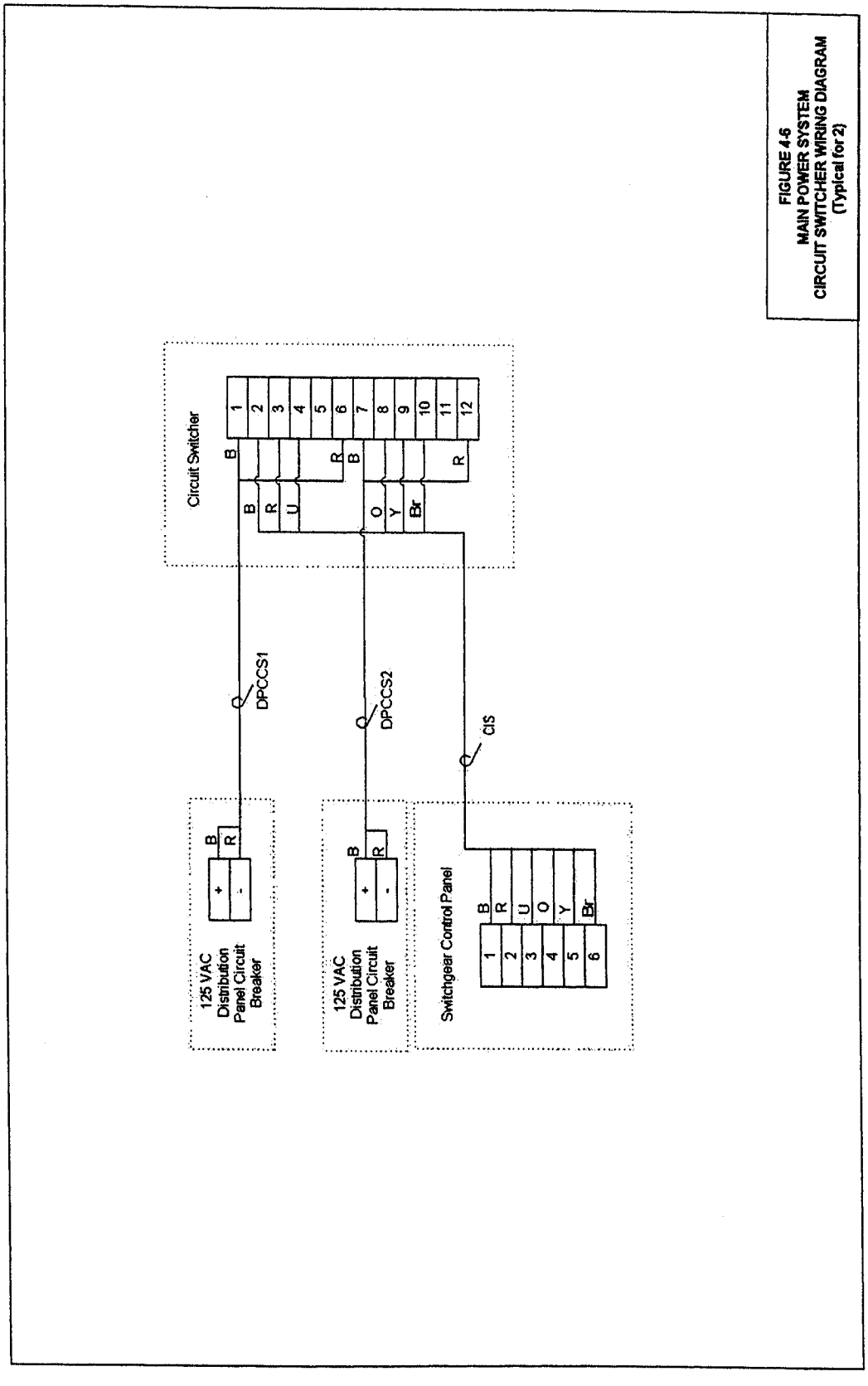


*Figure 4-6. Main power system circuit switcher wiring diagram (typical for 2)*

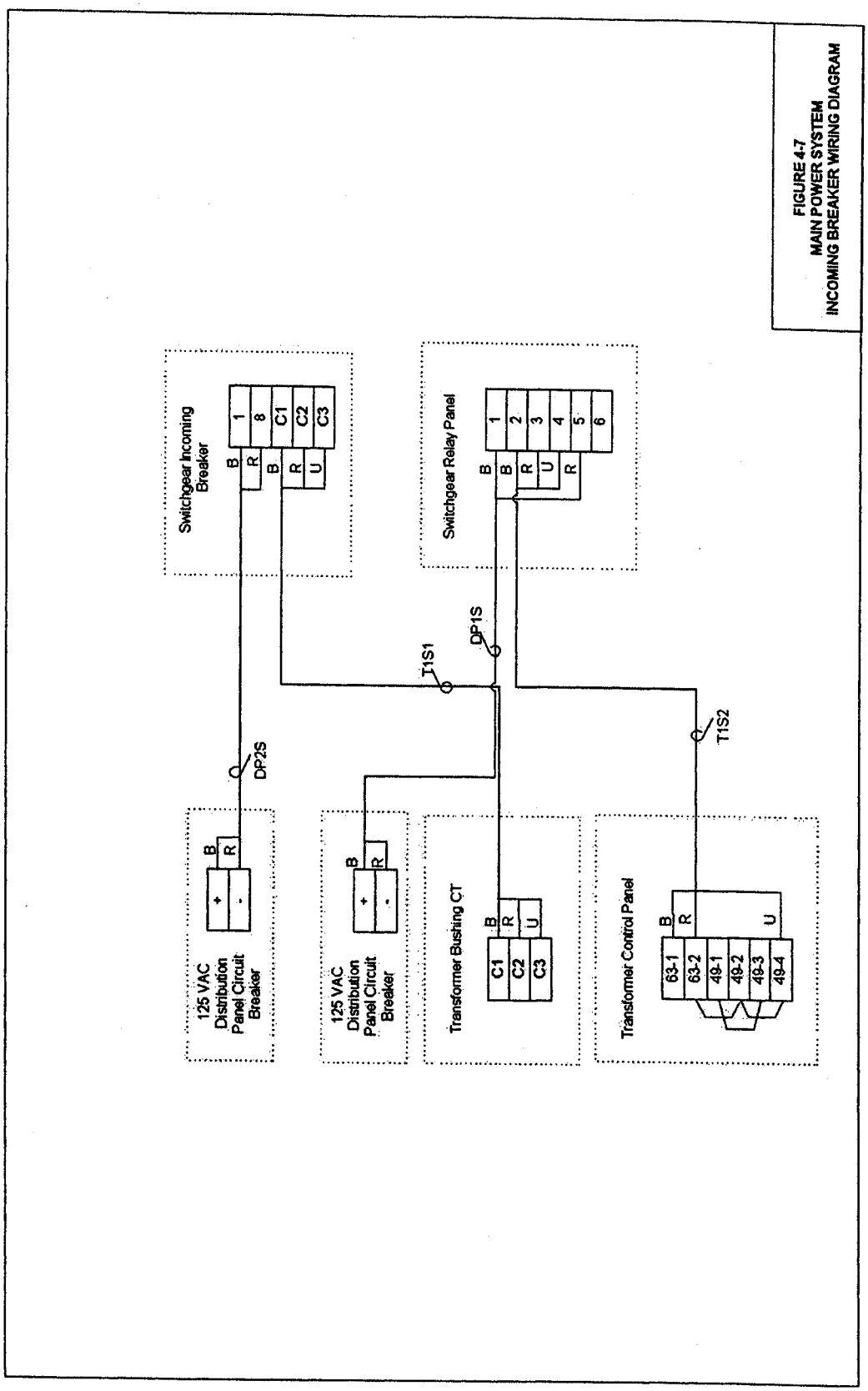


*Figure 4-7. Main power system incoming breaker wiring diagram*

## CIRCUIT SWITCHER INSPECTION CHECKLIST

For use of this form see TM 5-694; the proponent agency is COE.

**SECTION A - CUSTOMER DATA**

| 1. PLANT/BUILDING | 2. LOCATION | 3. JOB NUMBER |
|---|---|---|
| Bldg 1929 | Fort Tank | 02-117 |
| **4. EQUIPMENT** | **5. CIRCUIT DESIGNATION** | **6. DATE (YYYYMMDD)** |
| Switcher | P1 | 20020823 |
| **7. TEST EQUIPMENT TYPE/BRAND AND CALIBRATION DATE** | | **8. TESTED BY** |
| Sparls test set | | John Smith |

**SECTION B - EQUIPMENT DATA**

| 9. MANUFACTURER | 10. STYLES/S.O. | 11. VOLTAGE RATING | 12. CURRENT RATING |
|---|---|---|---|
| S&C | air/5673 | 35kV | 2000A |
| **13. INTERRUPTING RATING** | | **14. BUS BRACING** | |
| 500MVA | | 500MVA | |

**SECTION C - VISUAL AND ELECTRICAL/MECHANICAL INSPECTION**

| 15. CHECK POINT | COND* | NOTES | CHECK POINT | COND* | NOTES |
|---|---|---|---|---|---|
| EXTERIOR OF EQUIPMENT | A | | EQUIPMENT IDENTIFICATION | A | |
| COMPLETENESS OF ASSEMBLY | A | | BRACING | A | |
| ELECTRICAL/MECHANICAL INTERLOCKS | A | | PROPER PHASE CONNECTION AND COLOR CODE | A | |
| PROPER GROUNDING | A | | HAZARDOUS LOCATION | A | |
| ALIGNMENT AND ROTATION LIMITS | A | | CONTACT RESISTANCE | A | |
| TIGHTNESS OF BOLTED CONNECTIONS | A | | ANCHORAGE | A | |
| PROPER LUBRICATION | A | | REFERENCE DRAWINGS | A | |
| INTERRUPTER TIME TRAVEL | A | | CONTROL CIRCUIT OPERATION | A | |
| MANUAL OPERATION | A | | ENERGIZED OPERATION | A | |

**SECTION D - ELECTRICAL TESTS**

| 16. INSULATION RESISTANCE @ 5 kV | A-GRD | B-GRD | C-GRD | A-B | B-C | C-A |
|---|---|---|---|---|---|---|
| | 50 megohm | 75 megohm | 60 megohm | 80 megohm | 85 megohm | 80 megohm |

| 17. MEASUREMENT DESCRIPTION | VOLTAGE AND CURRENT MEASUREMENTS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | VOLTAGE** | | | | | | CURRENT** | | | | |
| | A-N | B-N | C-N | A-B | B-C | C-A | A | B | C | N | G |
| NA | | | | | | | | | | | |
| NA | | | | | | | | | | | |
| NA | | | | | | | | | | | |

18. NOTES:

1. Insulation resistance test performed on de-energized bus.
2. Bolts not torqued properly. Situation corrected.

*CONDITION: A = ACCEPTABLE; R = NEEDS REPAIR, REPLACEMENT OR ADJUSTMENT; C = CORRECTED; NA = NOT APPLICABLE
**NOTE VALUE AND PHASING

DA FORM 7463-R, USAPAV1.00

*Figure 4-8. Sample of completed DA Form 7463-R*

## TRANSFORMER INSPECTION CHECKLIST

For use of this form see TM 5-694; the proponent agency is COE.

**SECTION A - CUSTOMER DATA**

| 1. PLANT/BUILDING | 2. LOCATION | 3. JOB NUMBER |
|---|---|---|
| Bldg 358 | Fort Tank | 02-118 |
| **4. EQUIPMENT** | **5. CIRCUIT DESIGNATION** | **6. DATE (YYYYMMDD)** |
| XFMR-T1 | CKT-A | 20020823 |
| **7. TEST EQUIPMENT TYPE/BRAND AND CALIBRATION DATE** | | **8. TESTED BY** |
| AEMC Megger, DTR, Biddle DLRO, Power Factor Test Set | | John Smith |

**SECTION B - EQUIPMENT DATA**

| 9. MANUFACTURER | 10. STYLES/S.O. | 11. VOLTAGE RATING | 12. CURRENT RATING |
|---|---|---|---|
| Cooper | Oil-filled | 34500: 12470Y/7200 | 25MVA |
| **13. WET BULB TEMPERATURE** | **14. DRY BULB TEMPERATURE** | **15. ENCLOSURE TYPE** | **16. FREQUENCY** |
| 65 F | 85 F | | 60hz |

**SECTION C - VISUAL AND ELECTRICAL/MECHANICAL INSPECTION**

| 17. CHECK POINT | COND* | NOTES | CHECK POINT | COND* | NOTES |
|---|---|---|---|---|---|
| EXTERIOR OF EQUIPMENT | A | | PROPER PHASE CONNECTION AND COLOR CODE | A | |
| COMPLETENESS OF ASSEMBLY | A | | HAZARDOUS LOCATION | A | |
| PROPER GROUNDING | A | | WORKING CLEARANCE | A | |
| CONDITION OF INSULATION | A | | ANCHORAGE | A | |
| TIGHTNESS OF BOLTED CONNECTIONS | A | | REFERENCE DRAWINGS | A | |
| SEALS AND OIL LEVELS | R | 3. | TURNS RATIO MEASUREMENTS | A | |
| WINDING CONFIGURATION | A | | AUXILIARY DEVICE OPERATION | A | |

**SECTION D - ELECTRICAL TESTS**

| 18. INSULATION RESISTANCE | A-GRD | B-GRD | C-GRD | A-B | B-C | C-A |
|---|---|---|---|---|---|---|
| @ 5 k V | 70 megohm | 70 megohm | 85 megohm | | | |
| POLARIZATION INDEX | 2.5 | 2.7 | 2.7 | | | |
| TURNS RATIO TEST | | | | | | |
| POWER FACTOR | 0.5 | 0.5 | 0.45 | | | |
| PROPER VOLTAGE | | | | | | |

19. NOTES:

1. PERFORM GROUND RESISTANCE TESTS PRIOR TO ENERGIZING EQUIPMENT.
2. GROUND RESISTANCE TESTS MUST BE PERFORMED IN DRY CONDITIONS AND SHALL BE PERFORMED 48 HOURS AFTER RAINFALL.
3. REPLACE GASKET.

*CONDITION: A - ACCEPTABLE; R - NEEDS REPAIR, REPLACEMENT OR ADJUSTMENT; C - CORRECTED; NA - NOT APPLICABLE

DA FORM 7464-R, USAPA V1.00

*Figure 4-9. Sample of completed DA Form 7464-R*

## SWITCHGEAR INSPECTION CHECKLIST

For use of this form see TM 5-694; the proponent agency is COE.

### SECTION A - CUSTOMER DATA

| 1. PLANT/BUILDING | 2. LOCATION | 3. JOB NUMBER |
|---|---|---|
| Bldg 316 | Fort Tank | 02-119 |

| 4. CIRCUIT DESIGNATION | 5. CIRCUIT FED FROM | 6. CIRCUIT FED TO | 7. DATE (YYYYMMDD) |
|---|---|---|---|
| F5 | Main bus | F2 | 20020823 |

| 8. TEST EQUIPMENT TYPE/BRAND AND CALIBRATION DATE | 9. ENCLOSURE TYPE | 10. TESTED BY |
|---|---|---|
| AVO 414/ 5 Aug 2002 | Air | John Smith |

### SECTION B - EQUIPMENT DATA

| 11. MANUFACTURER | 12. STYLES/S.O. | 13. VOLTAGE RATING | 14. CURRENT RATING |
|---|---|---|---|
| Siemens | | 600V | 2000A |

| 15. INTERRUPTING RATING | 16. BUS BRACING |
|---|---|
| 50 kA | 50 MVA |

### SECTION C - VISUAL AND ELECTRICAL/MECHANICAL INSPECTION

| 17. CHECK POINT | COND* | NOTES | CHECK POINT | COND* | NOTES |
|---|---|---|---|---|---|
| EXTERIOR OF EQUIPMENT | A | | EQUIPMENT IDENTIFICATION | A | |
| REFERENCE DRAWINGS | A | | BRACING | A | |
| ELECTRICAL/MECHANICAL DRAW OUT MECHANISM AND INTERLOCKS | A | | PROPER PHASE CONNECTION AND COLOR CODE | A | |
| BUS AND SUPPORT INSULATORS | A | | HAZARDOUS LOCATION | A | |
| PROPER LUBRICATION | A | | WORKING CLEARANCE | A | |
| CLEAN SWITCHGEAR | A | | ANCHORAGE | A | |
| CHECK MANUAL OPERATION OF CIRCUIT BREAKERS AND RELAYS | A | | ALL FILTERS AND VENTS CLEAR | A | |
| TEST RELAYS (ACCORDING TO ELEC. STUDY RECOMMENDATIONS) | A | | CHECK PROPER EQUIPMENT GROUNDING TO GROUNDING BUS | A | |
| CHECK INSTRUMENT AND RELAY COVERS | A | | SWITCHES FOR FREEDOM OF MOVEMENT | A | |
| CHECK CIRCUIT BREAKER INSULATING PARTS | A | | CHECK INCOMING LINE CONNECTIONS TO MAIN BUS | A | |
| CHECK CIRCUIT BREAKER CONTACT SURFACES | A | | VERIFY PROPER SIZE BREAKERS/FUSES | A | |
| 18. VERIFY LIFT OR BUILT WINCH FOR HANDLING HEAVY PARTS | | | 19. VERIFY CORRECT OPERATION OF INDICATING LIGHTS, METERS, GAUGES, ETC. | | |
| 20. VERIFY BOLTED BUS CONNECTIONS TO MANUFACTURER RECOMMENDATIONS | | | 21. VERIFY SPACE HEATER IS PROVIDED AND OPERATIONAL | | |

### SECTION D - ELECTRICAL TESTS

| 22. INSULATION RESISTANCE @ 1000 V | A-GRD | B-GRD | C-GRD | A-B | B-C | C-A |
|---|---|---|---|---|---|---|
| | | | | | | |

| 23. MEASUREMENT DESCRIPTION | VOLTAGE AND CURRENT MEASUREMENTS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | VOLTAGE** | | | | | | CURRENT** | | | | |
| Main Secondary M1 | A-N | B-N | C-N | A-B | B-C | C-A | A | B | C | N | G |
| | 277 | 277 | 278 | 482 | 479 | 480 | 250 | 240 | 230 | 15 | 1.5 |
| | A-N | B-N | C-N | A-B | B-C | C-A | A | B | C | N | G |
| | | | | | | | | | | | |
| | A-N | B-N | C-N | A-B | B-C | C-A | A | B | C | N | G |
| | | | | | | | | | | | |

24. NOTES

1. VOLTAGE MEASUREMENTS TO BE MADE AFTER UTILITY SOURCE IS CONNECTED TO INCOMING BREAKER WITH THE UTILITY BREAKER OPEN.
2. INSULATION RESISTANCE TESTS MUST BE PERFORMED PRIOR TO ENERGIZING EQUIPMENT.

*CONDITION: A = ACCEPTABLE; R = NEEDS REPAIR, REPLACEMENT OR ADJUSTMENT; C = CORRECTED; NA = NOT APPLICABLE
**NOTE VALUE AND PHASING

DA FORM 7465-R, USAPA V1.00

*Figure 4-10. Sample of completed DA Form 7465-R*

## POWER CABLE INSPECTION CHECKLIST

For use of this form see TM 5-694; the proponent agency is COE.

**SECTION A - CUSTOMER DATA**

| 1. PLANT/BUILDING | 2. LOCATION | 3. JOB NUMBER |
|---|---|---|
| Bldg M-1 | Fort Tank | 02-120 |
| **4. EQUIPMENT** | **5. CIRCUIT DESIGNATION** | **6. DATE (YYYYMMDD)** |
| Cable | F1 | 20020823 |
| **7. TEST EQUIPMENT TYPE/BRAND AND CALIBRATION DATE** | | **8. TESTED BY** |
| AVO | | John Smith |

**SECTION B - EQUIPMENT DATA**

| 9. MANUFACTURER | 10. STYLES/S.O. | 11. VOLTAGE RATING | 12. CURRENT RATING |
|---|---|---|---|
| Rome | XLP | 15 kV | 500 MCM |
| **13. WET BULB TEMPERATURE** | **14. DRY BULB TEMPERATURE** | **15. ENCLOSURE TYPE** | **16. FREQUENCY** |
| 65 F | 85 F | | 60 hz |

**SECTION C - VISUAL AND ELECTRICAL/MECHANICAL INSPECTION**

| 17. CHECK POINT | COND* | NOTES | CHECK POINT | COND* | NOTES |
|---|---|---|---|---|---|
| EXTERIOR OF CABLE RUN | A | | BRACING AND SUPPORTS | A | |
| PROPER GROUNDING AT TERMINAL LUGS TO BUS | A | | CHECK PROPER SIZE OF CABLE | A | |
| REFERENCE EXISTING 1-LINE DIAGRAMS | A | | TIGHTNESS AND NEATNESS OF TERMINATIONS | A | |
| PROPER LUBRICATION | A | | ANCHORAGE | A | |
| CHECK GROUNDING AT SPLICE JOINTS | A | | CHECK PROPER SIZE TERMINAL LUGS AND MATERIAL | A | |
| CHECK CABLE PHASE COLOR CODE | A | | CHECK CABLE PHASE COORDINATION | A | |
| SHIELD CONTINUITY | R | 2. | CABLE IDENTIFICATION | A | |

**SECTION D - ELECTRICAL TESTS**

| 18. INSULATION RESISTANCE | A-GRD | B-GRD | C-GRD | A-B | B-C | C-A |
|---|---|---|---|---|---|---|
| APPLIED VOLTAGE 15 Kv | 20 megohm | 30 megohm | 35 megohm | | | |

19. NOTES

1. PERFORM HIGH POTENTIAL TESTS IN ACCORDANCE WITH SPECIFIED REQUIREMENTS OR MANUFACTURER(S) RECOMMENDATIONS.
2. GROUND SHIELDS WERE NOT TERMINATED PROPERLY.

*CONDITION: A = ACCEPTABLE; R = NEEDS REPAIR, REPLACEMENT OR ADJUSTMENT; C = CORRECTED; NA = NOT APPLICABLE

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*Figure 4-11. Sample of completed DA Form 7466-R*

## MAIN POWER ENERGIZATION CHECKLIST

For use of this form see TM 5-694; the proponent agency is COE.

**SECTION A - CUSTOMER DATA**

| 1. PLANT/BUILDING | 2. LOCATION | 3. JOB NUMBER |
|---|---|---|
| Bldg 2582 | Fort Tank | 02-121 |

| 4. CIRCUIT DESIGNATION | 5. CIRCUIT FED FROM | 6. CIRCUIT FED TO | 7. DATE *(YYYYMMDD)* |
|---|---|---|---|
| Main | Utility | Output CB | 20020823 |

| 8. TEST EQUIPMENT TYPE/BRAND AND CALIBRATION DATE | 9. TESTED BY |
|---|---|
| Fluke 45/ 7 Aug 2002 | John Smith |

**SECTION B - VISUAL AND ELECTRICAL/MECHANICAL INSPECTION**

| 10. CHECK POINT | COND* | NOTES | CHECK POINT | COND* | NOTES |
|---|---|---|---|---|---|
| COMPONENT INSPECTION/TESTING COMPLETED | A | | VERIFY SWITCHGEAR CONTROL FUNCTIONS | A | |
| WIRING VISUAL VERIFICATION | A | | CHECK FOR WORKING CLEARANCE | A | |
| VERIFY WIRING DIAGRAMS | A | | ENERGIZE AND TEST SYSTEM | A | |
| VERIFY CIRCUIT SWITCHER CONTROL FUNCTIONS | A | | TRANSFORMER TRANSFER CONTROL FUNCTIONS | A | |
| ENERGIZE AND TEST SYSTEM FOR ALL CONDITIONS | A | | CHECK FOR UNUSUAL SOUNDS AFTER ENERGIZING | A | |
| CHECK BUSHING OR TERMINALS | A | | CHECK ANCHORING OF TRANSFORMER SWITCHGEAR AND SWITCHES ENCLOSURE | A | |
| CHECK FOR REMOVAL OF PAINT OR HEAVY DENTS | A | | CHECK FOR NORMAL/ABNORMAL SWITCHING OPERATION | A | |

**SECTION C - ELECTRICAL TESTS**

| 11. MEASUREMENT DESCRIPTION | VOLTAGE AND CURRENT MEASUREMENTS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | VOLTAGE** | | | | | | CURRENT** | | | | |
| Main Feed | A-N | B-N | C-N | A-B | B-C | C-A | A | B | C | N | G |
| | 7630 | 7630 | 7630 | 13kV | 13kV | 13kV | 1200 | 1150 | 1200 | 125 | 5 |
| F1 | A-N | B-N | C-N | A-B | B-C | C-A | A | B | C | N | G |
| | | | | | | | | | | | |
| F2 | A-N | B-N | C-N | A-B | B-C | C-A | A | B | C | N | G |
| | | | | | | | | | | | |
| F3 | A-N | B-N | C-N | A-B | B-C | C-A | A | B | C | N | G |
| | | | | | | | | | | | |
| | A-N | B-N | C-N | A-B | B-C | C-A | A | B | C | N | G |
| | | | | | | | | | | | |

12. NOTES

1. Main circuit breaker did not open manually.
2. Voltage/current measurements should be compared with switchgear meters.

*CONDITION: A = ACCEPTABLE; R = NEEDS REPAIR, REPLACEMENT OR ADJUSTMENT; C = CORRECTED; NA = NOT APPLICABLE
**NOTE VALUE AND PHASING

DA FORM 7467-R, USAPA V1.00

*Figure 4-12. Sample of completed DA Form 7467-R*